LOCATING THE MOON

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THE SETTINC MOON METHOD

BY: Herb Power
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It is possible to have successful moonbounce contacts with a fully steerable antenna at one end of the circuit and an antenna pointing at the horizon at the other. Either a rising or setting moon can be used. In the method to be described, the eastern end of the circuit has an antenna variable in azimuth only. The western end must have a fully steerable antenna.

Follow the procedure below. This method has been used successfully by stations in the New York and New Jersey areas to contact California.

Construct the following graph on a piece of ten squares to the 1/2 inch graph paper: Y axis --- North 26° through South 26°. This scale should be 8° per inch and North 26° should be at the top of the page. Mark this axis DECLINATION. X axis --- 210° to 310°. This scale should be 10° per inch with 210° on the left. Mark this axis AZIMUTH.

At the intersection of 0° DECLINATION and 270° AZIMUTH place a dot. The following table lists LATITUDE vs AZIMUTH.

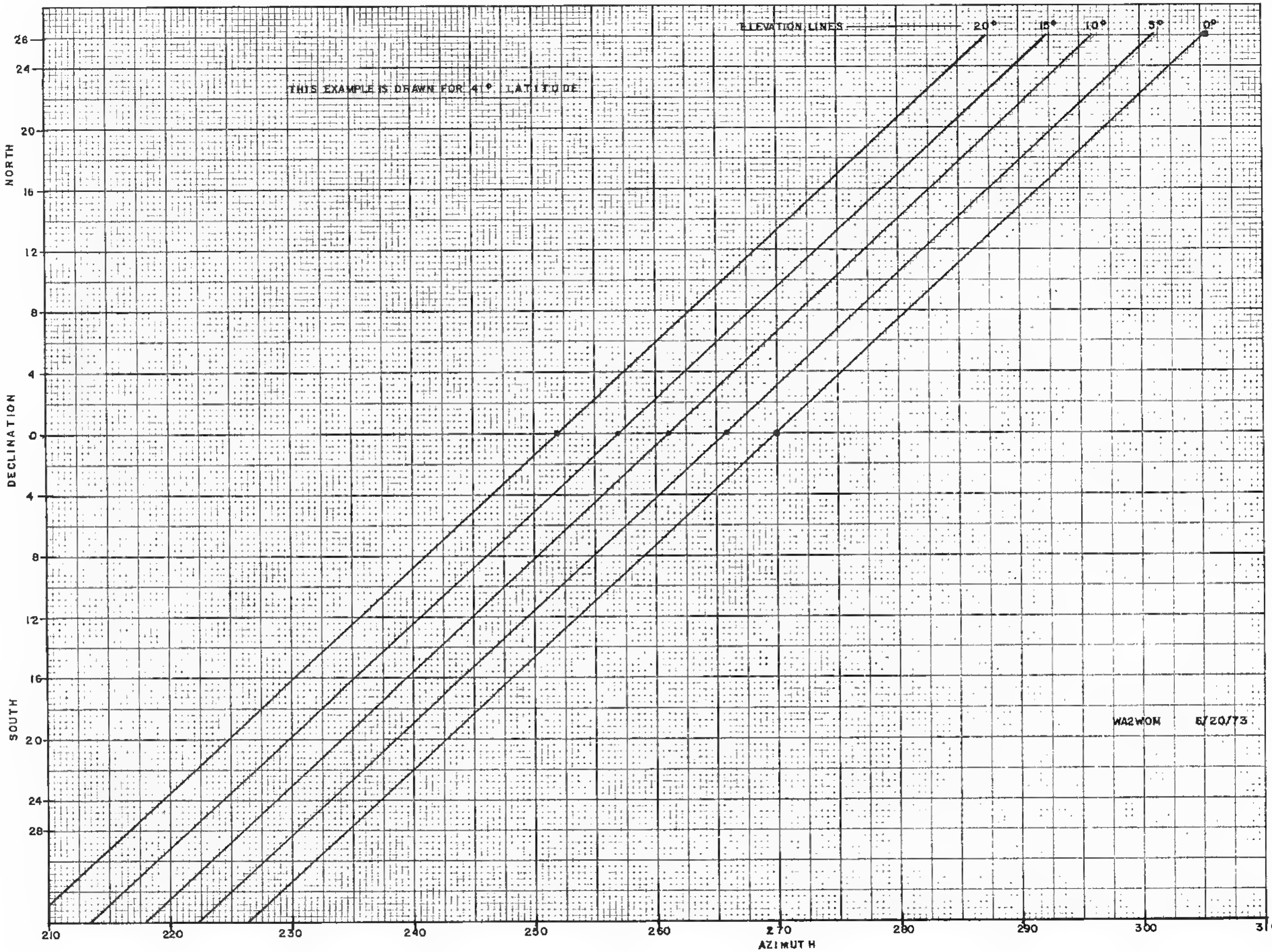
LAT.	AZIM.	LAT.	AZIM.	LAT.	AZIM.	LAT.	AZIM.
31°	300.8°	36°	302.8°	41°	305.5°	46°	309.1°
32°	301.1°	37°	303.3°	42°	306.2°	47°	310.0°
33°	301.5°	38°	303.8°	43°	306.8°	48°	310.9°
34°	301.9°	39°	304.3°	44°	307.5°	49°	311.9°
35°	302.4°	40°	304.9°	45°	308.3°	50°	313.0°

From the table select the AZIMUTH listed with your LATITUDE, place a dot at the intersection of this AZIMUTH and NORTH 26° DECLINATION. Draw a line between these two dots and continue it to the bottom of the graph. This is the 0° ELEVATION line. Mark the following points along the 0° DECLINATION line: 252°, 257°, 261° and 266°. Draw four lines, each parallel to the first and passing through one of the points. These are the 5°, 10°, 15° and 20° ELEVATION lines.

This family of curves (only these are straight lines) should look like the example. From the Nautical Almanac find the declination of the moon at moonset. A line drawn along this DECLINATION line describes the approximate path of the moon from 20° ELEVATION to Moonset. Since it takes about two hours to move this 20° you can now approximate the ELEVATION and AZIMUTH of the moon 2 hours prior to moonset.

It might be worthy to note that the 5, 10, 15 and 20 degree ELEVATION lines are really not straight but for all intents and purposes the error that is introduced is not significant for E.M.E. work. Also the major error happens to be in the very high southern DECLINATIONS and this is not a good period for E.M.E. work from the Northern Hemisphere.

No attempt was made to continue this chart higher than 20^{o} so I have no idea what would happen if an attempt was made to continue them. The data for the chart can be found in Hydrographic Office Publication 214 and anyone with the ambition can attempt to continue the chart.


ELEVATION LINES
20°
15°
10°
5°
0°
THIS EXAMPLE IS DRAWN FOR 41° LATITUDE
NORTH
DECLINATION
SOUTH
26
24
20
16
12
8
4
0
4
8
12
16
20
24
28
210
220
230
240
250
260
270
280
290
300
310
AZIMUTH
WA2WOM
6/20/73

USING THE HP-35 TO LOCATE THE MOON

Derived by: W6PO and WA2WOM

The following procedure is a technique for using the Hewlett-Packard HP-35 hand held calculator for determining the moon's AZIMUTH in relation to true north, and the ELEVATION with respect to the local horizon for the geographical location in question.

You must know the following:

1. LATITUDE in degrees for the geographical location (ex. 37.33^{o}).

2. LONGITUDE in degrees for the geographical location (ex. 122.13^{o}).

3. GHA (Greenwich Hour Angle) in degrees for the moon for the year, month, day and hour in question (ex. June 2, 1973 at 1900 GMT; GHA = 80.85^{o}).

4. DECLINATION in degrees for the moon for the year, month, day and hour in question (ex. June 2, 1973 at 1900 GMT; DECLINATION = N 23.36^{o}).

The LATITUDE and LONGITUDE may be obtained from Aeronautical Charts, City Engineers, good maps, etc.

The GHA and DECLINATION are obtainable from the "Nautical Almanac". The data are given in degrees and minutes. The minutes must be converted to decimal parts of degrees. The DECLINATION is given as North or South depending on whether the moon is above or below the celestial equator. When the moon has a north DECLINATION the sign of the angle is plus, and is minus for a south DECLINATION. The "Nautical Almanac" is published for each year and is available from the Government Printing Office (no GPO stock number), or from Government Bookstores. Another publication available from the same source is "The American Ephemeris and Nautical Almanac". This publication is much harder to use for amateur radio purposes.

The equations used are those given in the attached reprint on page 24 from "The Ephemeris of the Sun, Polaris and Other Selected Stars" for the year 1973. The Government Printing Office stock number for this publication is 2411-00038.

The equations as written and explained are applicable for the northern latitudes.

ELEVATION

[LONGITUDE] [ENTER] [GHA] [-] [COS] [DECLINATION] * [COS] [X]

[LATITUDE] [STO] [COS] [X] [DECLINATION] * [SIN] [RCL] [SIN] [X]

[+] [ARC] [SIN] = ELEVATION

* [CHS] Must be used for Southern declinations.

The answer is the angle in degrees the moon is above the local horizon.

AZIMUTH

[LATITUDE] [STO] [TAN] [ELEVATION] [TAN] [X] [DECLINATION] *

[SIN] [RCL] [COS] [÷] [ELEVATION] [COS] [÷] [X⇄Y] [-] [ARC] [COS] = [A]

* [CHS] Must be used for Southern declinations.

To get the AZIMUTH from true North:

1. If the GHA is east of your longitude: A = AZIMUTH

2. If the GHA is west of your longitude: 360° -A = AZIMUTH

Example:

LATITUDE	=	37.33°
LONGITUDE	=	122.13°
GHA	=	80.85° (June 2, 1973 at 1900 GMT)
DECLINATION	=	+23.36° (June 2, 1973 at 1900 GMT)
ELEVATION	=	52.09°
AZIMUTH	=	99.65°

For the special case where a station with a horizon antenna is using the setting moon, the AZIMUTH at moonset is of some use.

AZIMUTH AT MOONSET

[DECLINATION] * [SIN] [LATITUDE] [COS] [÷] [ARC] [COS] [360]

[X⇄Y] [-] = AZIMUTH

* [CHS] Must be used for Southern declinations.

EXPLANATIONS FOR THE STELLAR OBSERVATIONS

The data in this Ephemeris are arranged for the surveying practice of the Bureau of Land Management; the methods are useful in any survey where field observations are to be made for the ascertainment of the direction of a line in terms of angular value referred to the true meridian at that place.

In most cases, data are available as to the approximate latitude and longitude of the observing station, and preliminary determinations are made for the meridian and watch correction in terms of local mean time. The observations of the stars then follow on an observing program arranged for what is needed, and to suit the time of year, the latitude of the station, and other conditions that are factors.

A complete and well balanced stellar observing program will include: (1) the meridian passage of one star for time and latitude; (2) Polaris for azimuth and latitude; and (3) two well placed stars, one easterly and one westerly, both for azimuth, and one or both for time. The necessary verifications are thus accomplished. Instrumental uncertainties in the vertical angle readings are made apparent by this plan, and are compensated by taking the means of offsetting values. An observation may be made to verify only one or two values when the remainder are already well determined.

There are six stellar observing periods: (1) late afternoon, daylight; (2) early evening, twilight; (3) later p. m., after dark, illumination required; (4) after midnight, ditto; (5) early morning, twilight; and (6) after sunrise, daylight. The stars to be observed are chosen after deciding upon the observing period, and making the selection according to the desired position in hour angle and declination.

The time of a star's transit is to be reduced from the tabulated value for the Greenwich meridian to the longitude of the station; this is 10 seconds of time for each 15° (or one hour) of longitude, subtracted for west longitude (see table of Sidereal Conversions, page 27); this will give the correct local mean time at the moment of the star's meridian passage. The next step is to anticipate the probable local mean time of each observation, and the star's hour angle at that moment, to the east or to the west of the meridian.

The setting positions for the instrument in vertical angle (v) and in horizontal angle (A) are computed on the basis of the assumed hour angle (t), the star's declination (δ), and the known or approximate latitude (φ). This is done to secure a setting that is sufficiently accurate to bring the star within the field of the telescope, especially if the observation is to be by daylight, or twilight; less accuracy is needed just for the star's identification if the observation is to be made during starlight. The preliminary computations may be made with 4-place tables. The true values are obtained by reduction of the observations. The reductions for stellar observations are similar to the methods applicable to observations of the sun, and employ the same equations.

In all stellar observations, the true vertical angle (h) is equal to the observed vertical angle (v) minus the refraction (r) in zenith distance; there is no correction for parallax. In observations of the sun, the true vertical angle (h) is equal to (v) minus (r) plus parallax; see table, page 25.

In observations of the sun, the meridian passage and the hour angle (t) are in apparent solar time. The equation of time is applied to give the watch correction in terms of local mean time.

In observations of a star, the hour angle (t) is in terms of a sidereal rate; a subtraction of 10 seconds per hour will give the equivalent mean time hour angle. (Sidereal Conversions, page 27).

The following equations are regarded as the most useful for the methods stated above:

On the meridian, the vertical angle: $h = 90° - \varphi \pm \delta$; (or) $\varphi = 90° - h \pm \delta$

At any hour angle: $\sin h = \cos t \cos \varphi \cos \delta + \sin \varphi \sin \delta$

$$: \cos t = \frac{\sin h}{\cos \varphi \cos \delta} - \tan \varphi \tan \delta$$

$$: \cos A = \frac{\sin \delta}{\cos \varphi \cos h} - \tan \varphi \tan h$$

The product "$\sin \varphi \sin \delta$" and the fraction "$\frac{\sin \delta}{\cos \varphi \cos h}$" are negative for south declinations.

The product "$\cos t \cos \varphi \cos \delta$" is negative for hour angles exceeding six hours or 90°.

The product "$\tan \varphi \tan \delta$" is subtracted for north declinations; added for south declinations.

If the result for "cos A" is $\begin{Bmatrix}\text{positive}\\ \text{negative}\end{Bmatrix}$ the horizontal angle counts from the $\begin{Bmatrix}\text{north.}\\ \text{south.}\end{Bmatrix}$

If the result for "cos t" is $\begin{Bmatrix}\text{positive}\\ \text{negative}\end{Bmatrix}$ the hour angle is $\begin{Bmatrix}\text{less}\\ \text{more}\end{Bmatrix}$ than six hours or 90°.

By a stellar equal-altitude observation, the meridian is determined as the mean of two direction-pointings; the latitude is not required; there are no corrections as to declination. A mean of the watch readings at the moment of each observation is equivalent to a reading at the time of the star's meridian passage. The latitude may be reduced from the maximum vertical angle at meridian passage.

The equations as written and explained above are applicable for the northern latitudes; suitable transpositions are required for observations in the southern latitudes.

USE OF TABLES OF COMPUTED ALTITUDE AND AZIMUTH

BY: Joe Reisert
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A simple method of calculating the AZIMUTH and ELEVATION for aiming an EL-AZ mounted antenna at the moon is described herein. Two publications obtainable from the Government Printing Office, or from a Government Bookstore, along with the longitude and latitude of the antenna are all that are required. "The Nautical Almanac" (published yearly) has tables giving the location of the moon in GHA (Greenwich Hour Angle) and DECLINATION North and South of the celestial equator for the year, month, day and time (GMT) in question. The second publication is titled "Tables of Computed Altitude and Azimuth" - H.O. 214. This is a publication of the Hydrographic Office which has tables for converting GHA and DECLINATION into AZIMUTH and ELEVATION for a given latitude and longitude. There are several volumes available. Only one volume is required for a specific geographic location. Be certain to order the volume which includes your latitude. For instance, Volume IV is for latitudes 30°-39°, inclusive.

Procedure

1. Turn to pages containing your local latitude.

   a) The tables marked "DECLINATION SAME NAME AS LATITUDE" are for North Declinations if your latitude is North.

   b) The tables marked "DECLINATION CONTRARY NAME TO LATITUDE" are for South Declinations if your latitude is North.

2. HA (Hour Angle) is normalized to your GHA (Greenwich Hour Angle) east or west of your meridian. Therefore, renumber HA columns as follows:

   a) The column on the left hand side of each page is for descending HA.

      e.g.: If LHA (local hour angle) is 122° West longitude, renumber 00° as 122°, 1° as 121°, 2° as 120°, etc.

   b) The column on the right hand side of each page is for ascending HA.

      e.g.: If LHA is 122° West longitude, renumber 00° as 122°, 1° as 123°, 2° as 124°, etc.

3. The numbers across the top of the columns are DECLINATIONS.

      e.g.: 2° 30' refers to a DECLINATION of 2° 30'. Just below the DECLINATIONS are the local altitude and AZIMUTH columns.

Example 1.

GHA 71^{o} DECLINATION N 2^{o} (These moon data from Nautical Almanac for year, month, day, time (GMT) in question).

Local coordinates 122^{o} West longitude, 36^{o} North latitude.

Use the SAME page (since DECLINATION is the same (North) as compared to the local North latitude).

Use the left hand HA column since CHA is east of your meridian or before 122^{o} longitude (CHA 122^{o}). Go to HA 51^{o} (which is renumbered as 71^{o}) and across to DECLINATION equals 2^{o}.

Read ALTITUDE 31^{o} 57.6' and AZIMUTH 113.7^{o}.

Example 2.

GHA 181^{o} DECLINATION S 2^{o} (From Nautical Almanac).

Local coordinates 122^{o} West longitude, 36^{o} North latitude.

Use the CONTRARY page (since DECLINATION is contrary (South) as compared to local North latitude).

Use the right hand HA column since CHA 181^{o} is west of the 122^{o} local meridian. Go to HA 59^{o} (which is renumbered 181^{o}) and across to DECLINATION of 2^{o}.

Read ALTITUDE 23^{o} 19.4' and AZIMUTH 111.1^{o}. True AZIMUTH equals 360 - (column reading) for a GHA greater than the local hour angle. Therefore, $360^{o} - 111.1^{o} = 248.9^{o}$.

Lat. 36°	H.A.	0° 00′ Alt. Δd Δt Az.	0° 30′ Alt. Δd Δt Az.	1° 00′ Alt. Δd Δt Az.	1° 30′ Alt. Δd Δt Az.	2° 00′ Alt. Δd Δt Az.	2° 30′ Alt. Δd Δt Az.	3° 00′ Alt. Δd Δt Az.	3° 30′ Alt. Δd Δt Az.	H.A.	
	°	° ′ Δd Δt °	° ′ Δd Δt °	° ′ Δd Δt °	° ′ Δd Δt °	° ′ Δd Δt °	° ′ Δd Δt °	° ′ Δd Δt °	° ′ Δd Δt °	°	
122	00	54 00.0 1.0 01 180.0	54 30.0 1.0 01 180.0	55 00.0 1.0 01 180.0	55 30.0 1.0 01 180.0	56 00.0 1.0 01 180.0	56 30.0 1.0 01 180.0	57 00.0 1.0 01 180.0	57 30.0 1.0 01 180.0	00	122
	1	53 59.3 1.0 04 178.3	54 29.3 1.0 04 178.3	54 59.3 1.0 04 178.3	55 29.3 1.0 04 178.2	55 59.2 1.0 04 178.2	56 29.2 1.0 04 178.2	56 59.2 1.0 04 178.2	57 29.2 1.0 04 178.1	1	
	2	53 57.1 1.0 06 176.6	54 27.1 1.0 06 176.6	54 57.0 1.0 06 176.5	55 27.0 1.0 06 176.5	55 57.0 1.0 06 176.4	56 26.9 1.0 06 176.4	56 56.9 1.0 06 176.3	57 26.9 1.0 07 176.3	2	
	3	53 53.5 1.0 08 174.9	54 23.4 1.0 08 174.8	54 53.4 1.0 09 174.8	55 23.3 1.0 09 174.7	55 53.2 1.0 09 174.6	56 23.1 1.0 09 174.6	56 53.0 1.0 09 174.5	57 22.9 1.0 09 174.4	3	
	4	53 48.5 1.0 11 173.2	54 18.4 1.0 11 173.1	54 48.2 1.0 11 173.0	55 18.1 1.0 11 173.0	55 47.9 99 11 172.9	56 17.8 99 11 172.8	56 47.6 99 12 172.7	57 17.4 99 12 172.6	4	
117	05	53 42.1 99 13 171.5	54 11.8 99 13 171.4	54 41.6 99 13 171.3	55 11.4 99 14 171.2	55 41.2 99 14 171.1	56 10.9 99 14 171.0	56 40.7 99 14 170.9	57 10.4 99 14 170.8	05	127
	6	53 34.2 99 15 169.9	54 03.9 99 16 169.7	54 33.6 99 16 169.6	55 03.3 99 16 169.5	55 32.9 99 16 169.4	56 02.6 99 16 169.2	56 32.2 99 17 169.1	57 01.9 99 17 168.9	6	
	7	53 25.0 99 18 168.2	53 54.6 99 18 168.1	54 24.1 99 18 167.9	54 53.7 99 18 167.8	55 23.2 98 19 167.6	55 52.8 98 19 167.5	56 22.3 98 19 167.3	56 51.8 98 19 167.1	7	
	8	53 14.4 98 20 166.6	53 43.8 98 20 166.4	54 13.3 98 20 166.2	54 42.7 98 21 166.1	55 12.1 98 21 165.9	55 41.5 98 21 165.7	56 10.9 98 21 165.5	56 40.3 98 22 165.4	8	
	9	53 02.4 98 22 164.9	53 31.7 98 22 164.7	54 01.0 98 23 164.6	54 30.3 98 23 164.4	54 59.6 98 23 164.2	55 28.8 97 23 164.0	55 58.1 97 24 163.8	56 27.3 97 24 163.6	9	
112	10	52 49.1 97 24 163.3	53 18.3 97 25 163.1	53 47.4 97 25 162.9	54 16.6 97 25 162.7	54 45.7 97 25 162.5	55 14.8 97 26 162.3	55 43.8 97 26 162.1	56 12.9 97 26 161.8	10	132
	1	52 34.5 97 26 161.7	53 03.5 97 27 161.5	53 32.5 97 27 161.3	54 01.5 96 27 161.1	54 30.4 96 28 160.8	54 59.3 96 28 160.6	55 28.2 80 28 160.4	55 57.0 96 29 160.1	1	
	2	52 18.6 96 29 160.1	52 47.5 96 29 159.9	53 16.3 96 29 159.7	53 45.1 96 30 159.4	54 13.8 96 30 159.2	54 42.5 96 30 158.9	55 11.2 96 31 158.7	55 39.8 96 31 158.4	2	
	3	52 01.5 96 31 158.6	52 30.2 95 31 158.3	52 58.8 95 31 158.1	53 27.4 95 32 157.8	53 55.9 95 32 157.6	54 24.4 95 32 157.3	54 52.9 95 33 157.0	55 21.3 95 33 156.7	3	
	4	51 43.2 95 33 157.0	52 11.6 95 33 156.8	52 40.0 95 33 156.5	53 08.4 95 34 156.2	53 36.7 94 34 155.9	54 05.0 94 34 155.7	54 33.3 94 35 155.4	55 01.5 94 35 155.1	4	
107	15	51 23.6 94 35 155.5	51 51.9 94 35 155.2	52 20.1 94 35 154.9	52 48.2 94 36 154.7	53 16.3 94 36 154.4	53 44.4 94 36 154.1	54 12.5 93 37 153.8	54 40.4 93 37 153.5	15	137
	6	51 02.9 93 36 154.0	51 30.9 93 37 153.7	51 58.9 93 37 153.4	52 26.9 93 38 153.1	52 54.8 93 38 152.8	53 22.6 93 38 152.5	53 50.4 93 39 152.2	54 18.2 92 39 151.9	6	
	7	50 41.1 93 38 152.5	51 08.9 93 39 152.2	51 36.6 92 39 151.9	52 04.3 92 39 151.6	52 32.0 92 40 151.3	52 59.6 92 40 151.0	53 27.2 92 41 150.6	53 54.7 92 41 150.3	7	
	8	50 18.1 92 40 151.1	50 45.7 92 40 150.8	51 13.2 92 41 150.4	51 40.7 92 41 15.01	52 08.1 91 42 149.8	52 35.5 91 42 149.5	53 02.8 91 42 149.1	53 30.1 91 43 148.8	8	
	9	49 54.1 91 42 149.6	50 21.5 91 42 149.3	50 48.8 91 43 149.0	51 16.0 91 43 148.7	51 43.2 91 43 148.3	52 10.3 90 44 148.0	52 37.4 90 44 147.6	53 04.4 90 45 147.3	9	
102	20	49 29.1 80 43 148.2	49 56.2 90 44 147.9	50 23.2 80 44 147.6	50 50.2 90 45 147.2	51 17.2 80 45 146.9	51 44.0 89 45 146.5	52 10.8 89 46 146.1	52 37.6 89 46 145.8	20	142
	1	49 03.0 80 45 146.9	49 29.9 80 45 146.5	49 56.7 89 46 146.2	50 23.4 89 46 145.9	50 50.1 89 47 145.5	51 16.7 89 47 145.1	51 43.3 68 48 144.7	52 09.8 88 48 144.3	1	
	2	48 36.0 89 47 145.5	49 02.6 89 47 145.1	49 29.2 88 47 144.8	49 55.7 68 48 144.4	50 22.1 68 48 144.1	50 48.5 88 49 143.7	51 14.8 87 49 143.3	51 41.0 87 50 142.9	2	
	3	48 08.0 88 48 144.2	48 34.4 88 49 143.8	49 00.7 88 49 143.4	49 27.0 87 49 143.1	49 53.2 87 50 142.7	50 19.3 87 50 142.3	50 45.3 87 51 141.9	51 11.2 86 51 141.5	3	
	4	47 39.2 87 50 142.9	48 05.3 87 50 142.5	48 31.4 87 50 142.1	48 57.4 87 51 141.7	49 23.3 86 51 141.4	49 49.1 86 52 141.0	50 14.9 86 52 140.6	50 40.6 85 53 140.2	4	
97	25	47 09.4 86 51 141.6	47 35.3 86 51 141.2	48 01.1 86 52 140.8	48 26.9 86 52 140.4	48 52.5 85 53 140.0	49 18.1 85 53 139.6	49 43.6 85 54 139.2	50 09.1 85 54 138.8	25	147
	6	46 38.8 86 52 140.3	47 04.5 85 53 139.9	47 30.0 85 53 139.6	47 55.5 65 54 139.2	48 21.0 85 54 138.8	48 46.3 84 54 138.4	49 11.5 84 55 137.9	49 36.7 84 55 137.5	6	
	7	46 07.4 65 54 139.1	46 32.8 85 54 138.7	46 58.2 84 54 138.3	47 23.4 84 55 137.9	47 48.6 84 65 137.5	48 13.6 83 58 137.1	48 38.6 83 56 136.7	49 03.5 83 57 136.2	7	
	8	45 35.2 84 55 137.9	46 00.4 84 65 137.5	46 25.5 83 56 137.1	46 50.5 83 56 136.7	47 15.4 83 57 136.3	47 40.2 83 57 135.9	48 04.9 82 57 135.4	48 29.6 82 58 135.0	8	
	9	45 02.3 83 58 136.7	45 27.2 83 57 136.3	45 52.1 83 57 135.9	46 16.8 82 57 135.5	46 41.5 82 58 135.1	47 06.0 82 58 134.6	47 30.5 81 59 134.2	47 54.9 81 59 133.8	9	
92	30	44 28.6 82 57 135.5	44 53.3 82 58 135.1	45 17.9 82 58 134.7	45 42.4 82 58 134.3	46 06.8 81 59 133.9	46 31.1 81 59 133.5	46 55.4 81 60 133.0	47 19.5 80 60 132.6	30	152
	1	43 54.3 82 58 134.4	44 18.7 81 59 134.0	44 43.1 81 59 133.6	45 07.3 81 60 133.1	45 31.5 80 60 132.7	45 55.6 80 60 132.3	46 19.5 80 61 131.9	46 43.4 79 61 131.4	1	
	2	43 19.3 81 59 133.2	43 43.5 81 60 132.8	44 07.6 80 60 132.4	44 31.6 80 61 132.0	44 55.5 80 61 131.6	45 19.3 79 61 131.2	45 43.1 79 62 130.7	46 06.7 79 62 130.3	2	
	3	42 43.6 80 60 132.1	43 07.5 80 61 131.7	43 31.4 79 61 131.3	43 55.2 79 62 130.9	44 18.9 79 62 130.5	44 42.5 78 62 130.0	45 06.0 78 63 129.6	45 29.3 78 63 129.2	3	
	4	42 07.3 79 62 131.1	42 31.0 79 62 130.7	42 54.7, 79 62 130.2	43 18.2 78 83 129.8	43 41.7 78 63 129.4	44 05.0 78 63 128.9	44 28.3 77 64 128.5	44 51.4 77 64 128.1	4	
87	35	41 30.4 78 62 130.0	41 53.9 78 63 129.6	42 17.3 78 63 129.2	42 40.6 78 64 128.7	43 03.9 77 64 128.3	43 27.0 77 64 127.9	43 50.0 77 65 127.4	44 12.9 70 65 127.0	35	157
	6	40 52.9 78 63 129.0	41 16.2 77 64 128.6	41 39.4 77 64 128.1	42 02.5 77 64 127.7	42 25.5 76 65 127.3	42 48.4 76 65 126.8	43 11.2 76 86 126.4	43 33.9 75 60 125.9	6	
	7	40 14.9 77 64 128.0	40 38.0 77 65 127.5	41 01.0 76 65 127.1	41 23.8 76 65 126.7	41 46.6 76 66 126.2	42 09.3 75 66 125.8	42 31.8 75 66 125.4	42 54.3 75 07 124.9	7	
	8	39 36.4 76 65 127.0	39 59.2 76 65 126.5	40 22.0 76 68 126.1	40 44.6 75 68 125.7	41 07.2 75 66 125.2	41 29.7 75 67 124.8	41 52.0 74 67 124.4	42 14.3 74 68 123.9	8	
	9	38 57.4 76 80 126.0	39 20.0 75 66 125.6	39 42.5 75 67 125.1	40 05.0 75 67 124.7	40 27.3 74 67 124.3	40 49.6 74 68 123.8	41 11.7 74 68 123.4	41 33.7 73 66 122.9	9	
82	40	38 17.8 75 67 125.0	38 40.3 75 67 124.6	39 02.6 74 67 124.2	39 24.8 74 68 123.7	39 47.0 74 68 123.3	40 09.0 73 68 122.8	40 30.9 73 69 122.4	40 52.8 73 69 121.9	40	162
	1	37 37.9 74 67 124.1	38 00.1 74 68 123.6	38 22.2 74 68 123.2	38 44.2 73 68 122.8	39 06.2 73 69 122.3	39 28.0 73 69 121.9	39 49.7 72 69 121.4	40 11.4 72 70 121.0	1	
	2	36 57.4 74 68 123.1	37 19.4 73 68 122.7	37 41.4 73 69 122.3	38 03.2 73 69 121.8	38 24.9 72 69 121.4	38 46.6 72 70 121.0	39 08.1 72 70 120.5	39 29.6 71 70 120.1	2	
	3	36 16.6 73 69 122.2	36 38.4 73 69 121.8	37 00.1 72 69 121.4	37 21.8 72 70 120.9	37 43.3 72 70 120.5	38 04.8 71 70 120.1	38 26.1 71 71 119.6	38 47.4 71 71 119.2	3	
	4	35 35.3 72 69 121.3	35 56.9 72 70 120.9	36 18.5 72 70 120.5	36 39.9 71 70 120.0	37 01.3 71 71 119.6	37 22.6 71 71 119.2	37 43.7 70 71 118.7	38 04.8 70 72 118.3	4	
77	45	34 53.6 72 70 120.4	35 15.1 71 70 120.0	35 36.5 71 71 119.6	35 57.7 71 71 119.2	36 18.9 70 71 118.7	36 40.0 70 72 118.3	37 01.0 70 72 117.8	37 21.8 69 72 117.4	45	167
	6	34 11.6 71 71 119.6	34 32.9 71 71 119.2	34 54.1 70 71 118.7	35 15.2 70 72 [illegible]	35 36.2 70 72 117.8	35 57.1 70 72 117.4	36 17.9 69 72 117.0	36 38.6 69 73 116.5	6	
	7	33 29.2 70 71 118.7	33 50.3 70 72 118.3	34 11.3 70 72 117.9	34 32.3 70 72 [illegible]	34 53.1 69 72 117.0	35 13.8 69 73 116.6	35 34.4 69 73 116.1	35 55.0 68 73 115.7	7	
	8	32 46.5 70 72 117.9	33 07.4 70 72 117.5	33 28.3 69 72 117.0	33 49.0 69 73 [illegible]	34 09.7 69 73 116.2	34 30.2 68 73 115.7	34 50.7 68 73 115.3	35 11.1 68 74 114.8	8	
	9	32 03.4 69 72 117.1	32 24.2 69 73 116.6	32 44.9 69 73 116.2	33 05.4 68 73 [illegible]	33 25.9 66 73 115.3	33 46.3 68 74 114.9	34 06.7 68 74 114.5	34 26.9 67 74 114.0	9	
72	50	31 20.0 69 73 116.3	31 40.6 69 73 115.8	32 01.2 68 73 115.4	32 21.6 68 74 115.0	[illegible]	33 02.2 67 74 114.1	33 22.3 07 74 113.6	33 42.4 07 75 113.2	50	172
	1	30 36.4 68 73 115.5	30 56.8 68 74 115.0	31 17.2 68 74 114.6	31 37.4 67 74 114.2	31 57.6 67 74 113.7	32 17.7 67 75 113.3	32 37.7 67 75 112.9	32 57.6 86 75 112.4	1	
	2	29 52.4 68 74 114.7	30 12.7 68 74 114.2	30 32.9 67 74 113.8	30 53.0 67 74 113.4	[illegible]	31 33.0 66 75 112.5	31 52.9 66 75 112.1	32 12.6 66 75 111.6	2	
	3	29 08.1 67 74 113.9	29 28.3 67 74 113.5	29 48.4 67 75 113.0	30 08.3 60 75 112.6	30 28.2 66 75 112.2	30 48.0 66 75 111.7	31 07.8 66 76 111.3	31 27.4 65 76 110.9	3	
	4	28 23.6 67 75 113.1	28 43.6 67 75 112.7	29 03.6 66 75 112.3	29 23.4 60 75 111.8	29 43.2 66 76 111.4	30 02.8 65 76 111.0	30 22.4 65 76 110.5	30 41.9 65 76 110.1	4	
67	55	27 38.9 66 75 112.4	27 58.7 80 75 111.9	28 18.5 66 75 111.5	28 38.2 66 76 111.1	28 57.9 65 76 110.7	29 17.4 65 76 110.2	29 36.9 65 76 109.8	29 56.2 64 76 109.3	55	177
	6	26 53.9 66 75 111.6	27 13.6 66 76 111.2	27 33.2 65 76 110.8	27 52.8 65 76 110.4	28 12.3 65 76 109.9	28 31.7 65 76 109.5	28 51.1 64 77 109.1	29 10.3 64 77 108.6	6	
	7	26 08.6 65 76 110.9	26 28.2 65 76 110.5	26 47.8 65 76 110.0	27 07.2 85 76 109.6	27 26.6 64 77 109.2	27 45.9 64 77 108.8	28 05.1 64 77 108.3	28 24.2 64 77 107.9	7	
	8	25 23.2 65 76 110.2	25 42.6 65 76 109.7	26 02.0 65 76 109.3	26 21.4 64 77 108.9	26 40.6 64 77 108.5	26 59.8 64 77 108.0	27 18.9 64 77 107.6	27 37.9 63 77 107.2	8	
	9	24 37.5 65 78 109.5	24 56.9 64 77 109.0	25 16.1 64 77 108.6	25 35.4 04 77 108.2	25 54.5 64 77 107.8	26 13.6 63 77 107.3	26 32.6 63 78 106.9	26 51.5 63 78 106.5	9	
62	60	23 51.6 64 77 108.7	24 10.9 64 77 108.3	24 30.0 61 77 107.9	24 49.2 64 77 107.5	25 08.2 63 77 107.1	25 27.1 63 78 106.6	25 46.0 63 78 106.2	26 04.8 63 78 105.8	60	182
	1	23 05.6 64 77 108.0	23 24.7 64 77 107.6	23 43.8 63 77 107.2	24 02.8 63 78 106.8	24 21.7 63 78 106.4	24 40.6 63 78 105.9	24 59.3 62 78 105.5	25 18.1 62 78 105.1	1	
	2	22 19.3 64 77 107.4	22 38.3 63 78 106.9	22 57.3 63 78 106.5	23 16.2 63 78 106.1	23 35.0 63 78 105.7	23 53.8 62 78 105.2	24 12.5 62 78 104.8	24 31.1 62 78 104.4	2	
	3	21 32.9 83 78 106.7	21 51.8 83 78 106.3	22 10.7 63 78 105.8	22 29.5 63 78 105.4	22 48.2 62 78 105.0	23 06.9 62 78 104.6	23 25.5 62 79 104.1	23 44.0 62 79 103.7	3	
	4	20 46.3 63 78 106.0	21 05.1 83 78 105.6	21 23.9 62 78 105.2	21 42.6 62 78 104.7	22 01.3 62 78 104.3	22 19.8 62 79 103.9	22 38.3 62 79 103.5	22 56.8 61 79 103.0	4	
57	65	19 59.6 63 78 105.3	20 18.3 62 78 104.9	20 37.0 62 78 104.5	20 55.6 62 79 104.1	21 14.2 62 79 103.7	21 32.7 62 79 103.2	21 51.1 61 79 102.8	22 09.4 61 79 102.4	65	187
	6	19 12.7 62 78 104.7	19 31.3 62 79 104.3	19 49.9 62 79 103.8	20 08.5 62 79 103.4	20 26.9 61 79 103.0	20 45.3 61 79 102.6	21 03.7 61 79 102.1	21 22.0 61 79 101.7	6	
	7	18 25.7 62 79 104.0	18 44.2 62 79 103.6	19 02.7 62 79 103.2	19 21.2 61 79 102.8	19 39.6 61 79 102.3	19 57.9 61 79 101.9	20 16.2 61 79 101.5	20 34.4 61 79 101.1	7	
	8	17 38.5 62 79 103.4	17 57.0 62 79 102.9	18 15.4 61 79 102.5	18 33.8 61 79 102.1	18 52.1 61 79 101.7	19 10.4 61 79 101.3	19 28.6 61 80 100.9	19 46.7 80 80 100.4	8	
	9	16 51.2 61 79 102.7	17 09.6 61 79 102.3	17 28.0 61 79 101.9	17 46.3 61 79 101.5	18 04.5 61 79 101.1	18 22.7 61 80 100.6	18 40.8 80 80 100.2	18 58.9 60 80 99.8	9	
52	70	16 03.8 61 79 102.1	16 22.1 61 79 101.7	16 40.4 61 79 101.2	16 53.6 61 80 100.8	17 16.8 61 80 100.4	17 34.9 80 80 100.0	17 53.0 60 80 99.6	18 11.0 60 80 99.2	70	192
	1	15 16.3 61 79 101.4	15 34.5 61 80 101.0	15 52.7 61 80 100.6	16 10.9 60 80 100.2	16 29.0 80 80 99.8	16 47.1 80 80 99.4	17 05.1 60 80 99.0	17 23.1 80 80 98.5	1	
	2	14 28.7 61 80 100.8	14 46.8 61 80 100.4	15 05.0 60 80 100.0	15 23.1 60 80 99.6	15 41.1 60 80 99.2	15 59.2 80 80 98.7	16 17.1 60 80 98.3	16 35.0 60 80 97.9	2	
	3	13 40.9 80 80 100.2	13 59.1 60 80 99.8	14 17.1 60 80 99.4	14 35.2 60 80 99.0	14 53.2 60 80 98.5	15 11.1 60 80 98.1	15 29.0 60 60 97.7	15 46.9 59 80 97.3	3	
	4	12 53.1 60 80 99.6	13 11.2 60 80 99.2	13 29.2 60 80 98.7	13 47.2 60 80 98.3	14 05.1 60 80 97.9	14 23.0 80 80 97.5	14 40.9 59 80 97.1	14 58.7 59 80 96.7	4	
47	75	12 05.2 80 80 99.0	12 23.2 60 80 98.5	12 41.2 60 80 98.1	12 59.1 60 80 97.7	13 17.0 80 80 97.3	13 34.9 59 80 96.9	13 52.7 59 80 96.5	14 10.5 59 80 96.1	75	197
	6	11 17.2 80 80 98.3	11 35.2 60 80 97.9	11 53.1 80 80 97.5	12 11.0 80 80 97.1	12 28.9 59 80 96.7	12 46.7 59 80 96.3	13 04.5 59 81 95.9	13 22.2 59 81 95.5	6	
	7	10 29.1 80 80 97.7	10 47.1 80 80 97.3	11 04.9 80 80 96.9	11 22.8 59 80 96.5	11 40.6 59 80 96.1	11 58.4 59 81 95.7	12 16.1 59 81 95.3	12 33.9 59 81 94.9	7	
	8	9 41.0 60 80 97.1	9 58.9 60 80 96.7	10 16.7 59 80 96.3	10 34.5 50 80 95.9	10 52.3 59 81 95.5	11 10.1 59 81 95.1	11 27.8 59 81 94.7	11 45.5 59 81 94.3	8	
	9	8 52.8 59 80 96.5	9 10.6 59 80 96.1	9 28.4 59 81 95.7	9 46.2 59 81 95.3	10 04.0 59 81 94.9	10 21.7 59 81 94.5	10 39.4 59 81 94.1	10 57.0 59 81 93.7	9	
42	80	8 04.6 59 60 95.9	8 22.4 59 81 95.5	8 40.1 59 81 95.1	8 57.9 59 81 94.7	9 15.6 59 81 94.3	9 33.3 59 81 93.9	9 50.9 59 81 93.5	10 08.6 59 81 93.1	80	202
	1	7 16.2 59 81 95.3	7 34.0 59 81 94.9	7 51.8 59 81 94.5	8 09.5 59 81 94.1	8 27.2 59 81 93.7	8 44.8 59 81 93.3	9 02.5 59 81 92.9	9 20.1 59 81 92.5	1	
	2	6 27.9 59 81 94.7	6 45.6 59 81 94.3	7 03.3 59 81 93.9	7 21.0 59 81 93.5	7 38.7 60 81 93.1	7 56.4 59 81 92.7	8 14.0 59 81 92.3	8 31.6 59 81 91.9	2	
	3	5 39.5 59 81 94.1	5 57.2 59 81 93.7	6 14.9 59 81 93.3	6 32.6 59 81 92.9	6 50.2 59 81 92.5	7 07.9 59 81 92.1	7 25.5 59 81 91.7	7 43.1 59 81 91.3	3	
	4		5 08.8 59 81 93.1	5 26.4 59 81 92.7	5 44.1 59 81 92.3	6 01.7 59 81 91.9	6 19.3 59 81 91.5	6 36.9 59 81 91.1	6 54.5 59 81 90.7	4	
37	85					5 13.2 59 81 91.3	5 30.8 59 81 90.9	5 48.4 59 81 90.5	6 06.0 59 81 90.1	85	207
	6								5 17.5 59 81 89.5	6	

	H.A.	0° 00′			0° 30′			1° 00′			1° 30′			2° 00′			2° 30′			3° 00′			3° 30′			H.A.	Lat. 36°
		Alt.		Az.	Alt.		Az.	Alt.		Az.	Alt.		Az.	Alt.		Az.	Alt.		Az.	Alt.		Az.	Alt.		Az.		
	°	° ′	Δd Δt	°	° ′	Δd Δt	°	° ′	Δd Δt	°	° ′	Δd Δt	°	° ′	Δd Δt	°	° ′	Δd Δt	°	° ′	Δd Δt	°	° ′	Δd Δt	°	°	
122	00	54 00.0	1.0 01	180.0	53 30.0	1.0 01	180.0	53 00.0	1.0 01	180.0	52 30.0	1.0 01	180.0	52 00.0	1.0 01	180.0	51 30.0	1.0 01	180.0	51 00.0	1.0 01	180.0	50 30.0	1.0 01	180.0	00	122
	1	53 59.3	1.0 04	178.3	53 29.3	1.0 04	178.3	52 59.3	1.0 04	178.3	52 29.3	1.0 03	178.4	51 59.3	1.0 03	178.4	51 29.3	1.0 03	178.4	50 59.3	1.0 03	178.4	50 29.3	1.0 03	178.4	1	
	2	53 57.1	1.0 06	176.6	53 27.2	1.0 06	176.6	52 57.2	1.0 06	176.7	52 27.2	1.0 06	176.7	51 57.3	1.0 06	176.8	51 27.3	1.0 06	176.8	50 57.3	1.0 06	176.8	50 27.3	1.0 06	176.9	2	
	3	53 53.5	1.0 08	174.9	53 23.6	1.0 08	175.0	52 53.7	1.0 08	175.0	52 23.7	1.0 08	175.1	51 53.8	1.0 08	175.1	51 23.9	1.0 08	175.2	50 54.0	1.0 08	175.2	50 24.0	1.0 08	175.3	3	
	4	53 48.5	1.0 11	173.2	53 18.6	1.0 11	173.3	52 48.8	1.0 10	173.4	52 18.9	1.0 10	173.4	51 49.0	1.0 10	173.5	51 19.1	1.0 10	173.6	50 49.3	1.0 10	173.7	50 19.4	1.0 10	173.7	4	
117	05	53 42.1	99 13	171.5	53 12.3	99 13	171.6	52 42.5	99 13	171.7	52 12.7	99 13	171.8	51 42.9	99 12	171.9	51 13.1	99 12	172.0	50 43.3	99 12	172.1	50 13.4	99 12	172.2	05	127
	6	53 34.2	99 15	169.9	53 04.5	99 15	170.0	52 34.8	99 15	170.1	52 05.1	99 15	170.2	51 35.4	99 15	170.3	51 05.7	99 15	170.4	50 35.9	99 14	170.5	50 06.2	99 14	170.6	6	
	7	53 25.0	99 18	168.2	52 55.4	99 17	168.3	52 25.8	99 17	168.5	51 56.2	99 17	168.6	51 26.6	99 17	168.7	50 56.9	99 17	168.9	50 27.3	99 17	169.0	49 57.7	99 16	169.1	7	
	8	53 14.4	98 20	166.6	52 44.9	98 20	166.7	52 15.4	98 20	166.9	51 45.9	98 19	167.0	51 16.4	98 19	167.2	50 46.9	98 19	167.3	50 17.4	98 19	167.4	49 47.8	98 18	167.6	8	
	9	53 02.4	98 22	164.9	52 33.1	98 22	165.1	52 03.7	98 22	165.3	51 34.4	98 21	165.4	51 05.0	98 21	165.6	50 35.6	98 21	165.7	50 06.2	98 21	165.9	49 36.8	98 21	166.1	9	
112	10	52 49.1	97 24	163.3	52 19.9	97 24	163.5	51 50.7	97 24	163.7	51 21.5	97 24	163.9	50 52.3	97 23	164.0	50 23.0	98 23	164.2	49 53.7	98 23	164.4	49 24.5	98 23	164.6	10	132
	1	52 34.5	97 26	161.7	52 05.5	97 26	161.9	51 36.4	97 26	162.1	51 07.4	97 26	162.3	50 38.3	97 25	162.5	50 09.2	97 25	162.7	49 40.1	97 25	162.9	49 10.9	97 25	163.1	1	
	2	52 18.6	96 29	160.1	51 49.8	96 28	160.3	51 20.9	96 28	160.6	50 52.0	96 28	160.8	50 23.1	96 27	161.0	49 54.1	97 27	161.2	49 25.2	97 27	161.4	48 56.2	97 27	161.6	2	
	3	52 01.5	96 31	158.6	51 32.8	96 30	158.8	51 04.1	96 30	159.0	50 35.4	96 30	159.3	50 06.7	96 29	159.5	49 37.9	96 29	159.7	49 09.1	96 29	159.9	48 40.2	96 28	160.1	3	
	4	51 43.2	95 33	157.0	51 14.7	95 32	157.3	50 46.2	95 32	157.5	50 17.6	95 32	157.8	49 49.1	95 31	158.0	49 20.5	95 31	158.2	48 51.8	95 31	158.5	48 23.2	96 30	158.7	4	
107	15	51 23.6	94 35	155.5	50 55.3	94 34	155.8	50 27.0	94 34	156.0	49 58.7	95 33	156.3	49 30.3	95 33	156.5	49 01.9	95 33	156.8	48 33.4	95 33	157.0	48 05.0	95 32	157.3	15	137
	6	51 02.9	93 36	154.0	50 34.8	94 36	154.3	50 06.7	94 36	154.5	49 38.6	94 35	154.8	49 10.4	94 35	155.1	48 42.2	94 35	155.3	48 13.9	94 34	155.6	47 45.6	94 34	155.8	6	
	7	50 41.1	93 38	152.5	50 13.2	93 38	152.8	49 45.3	93 38	153.1	49 17.4	93 37	153.4	48 49.4	93 37	153.7	48 21.4	93 36	153.9	47 53.3	93 36	154.2	47 25.2	94 36	154.4	7	
	8	50 18.1	92 40	151.1	49 50.5	92 40	151.4	49 22.8	92 39	151.7	48 55.1	92 39	152.0	48 27.3	93 39	152.2	47 59.5	93 38	152.5	47 31.7	93 38	152.8	47 03.8	93 38	153.1	8	
	9	49 54.1	91 42	149.6	49 26.7	91 41	150.0	48 59.2	92 41	150.3	48 31.7	92 41	150.6	48 04.2	92 40	150.9	47 36.6	92 40	151.2	47 09.0	92 40	151.4	46 41.3	92 39	151.7	9	
102	20	49 29.1	90 43	148.2	49 01.9	91 43	148.6	48 34.7	91 43	148.9	48 07.4	91 42	149.2	47 40.1	91 42	149.5	47 12.7	91 42	149.8	46 45.3	91 41	150.1	46 17.8	92 41	150.4	20	142
	1	49 03.0	90 45	146.9	48 36.1	90 45	147.2	48 09.1	90 44	147.5	47 42.0	90 44	147.8	47 14.9	90 43	148.2	46 47.8	91 43	148.5	46 20.6	91 43	148.8	45 53.3	91 42	149.1	1	
	2	48 36.0	89 47	145.5	48 09.3	89 46	145.8	47 42.5	89 46	146.2	47 15.7	89 45	146.5	46 48.8	90 45	146.8	46 21.9	90 45	147.2	45 54.9	90 44	147.5	45 27.9	90 44	147.8	2	
	3	48 08.0	88 48	144.2	47 41.6	88 48	144.5	47 15.0	88 47	144.9	46 48.5	89 47	145.2	46 21.8	89 47	145.5	45 55.1	89 46	145.9	45 28.4	89 46	146.2	45 01.6	89 45	146.5	3	
	4	47 39.2	87 50	142.9	47 12.9	87 49	143.2	46 46.7	88 49	143.6	46 20.3	88 48	143.9	45 53.9	88 48	144.3	45 27.5	88 48	144.6	45 00.9	89 47	144.9	44 34.4	89 47	145.3	4	
97	25	47 09.4	86 51	141.6	46 43.4	87 51	141.9	46 17.4	87 50	142.3	45 51.3	87 50	142.7	45 25.1	87 49	143.0	44 58.9	88 49	143.4	44 32.6	88 49	143.7	44 06.3	88 48	144.0	25	147
	6	46 38.8	86 52	140.3	46 13.1	86 52	140.7	45 47.3	86 52	141.1	45 21.4	86 51	141.4	44 55.5	87 51	141.8	44 29.5	87 50	142.1	44 03.5	87 50	142.5	43 37.3	87 50	142.8	6	
	7	46 07.4	85 54	139.1	45 42.0	85 53	139.5	45 16.4	85 53	139.8	44 50.8	86 52	140.2	44 25.1	86 52	140.6	43 59.3	86 52	140.9	43 33.5	86 51	141.3	43 07.6	86 51	141.6	7	
	8	45 35.2	84 55	137.9	45 10.0	84 54	138.3	44 44.7	85 54	138.6	44 19.3	85 54	139.0	43 53.9	85 53	139.4	43 28.3	85 53	139.7	43 02.7	85 53	140.1	42 37.1	86 52	140.4	8	
	9	45 02.3	83 56	136.7	44 37.3	83 56	137.1	44 12.2	84 55	137.5	43 47.1	84 55	137.8	43 21.9	84 54	138.2	42 56.6	84 54	138.6	42 31.2	85 54	138.9	42 05.8	85 53	139.3	9	
92	30	44 28.6	82 57	135.5	44 03.9	83 57	135.9	43 39.1	83 56	136.3	43 14.1	83 56	136.7	42 49.2	83 56	137.1	42 24.1	84 55	137.4	41 59.0	84 55	137.8	41 33.8	84 55	138.2	30	152
	1	43 54.3	82 58	134.4	43 29.8	82 58	134.8	43 05.2	82 58	135.2	42 40.5	82 57	135.5	42 15.7	83 57	135.9	41 50.9	83 56	136.3	41 26.0	83 56	136.7	41 01.0	83 56	137.1	1	
	2	43 19.3	81 59	133.2	42 55.0	81 59	133.7	42 30.6	81 59	134.0	42 06.2	82 58	134.4	41 41.6	82 58	134.8	41 17.0	82 58	135.2	40 52.4	82 57	135.6	40 27.6	83 57	136.0	2	
	3	42 43.6	80 60	132.1	42 19.5	80 60	132.6	41 55.4	81 60	133.0	41 31.2	81 60	133.4	41 06.9	81 59	133.7	40 42.5	81 59	134.1	40 18.1	82 58	134.5	39 53.6	82 58	134.9	3	
	4	42 07.3	70 62	131.1	41 43.5	80 61	131.5	41 19.6	80 61	131.9	40 55.6	80 60	132.3	40 31.5	80 60	132.7	40 07.4	81 60	133.1	39 43.1	81 59	133.4	39 18.8	81 59	133.8	4	
87	35	41 30.4	78 62	130.0	41 06.8	79 62	130.4	40 43.1	79 62	130.8	40 19.4	79 61	131.2	39 55.5	80 61	131.6	39 31.6	80 61	132.0	39 07.6	80 60	132.4	38 43.5	80 60	132.8	35	157
	6	40 52.9	78 63	129.0	40 29.6	78 63	129.4	40 06.1	78 63	129.8	39 42.6	79 62	130.2	39 19.0	79 62	130.6	38 55.3	79 62	131.0	38 31.5	79 61	131.4	38 07.6	60 61	131.8	6	
	7	40 14.9	77 64	128.0	39 51.8	77 64	128.4	39 28.6	78 64	128.8	39 05.2	78 63	129.2	38 41.8	78 63	129.6	38 18.3	78 62	130.0	37 54.8	79 62	130.4	37 31.1	79 62	130.8	7	
	8	39 36.4	70 65	127.0	39 13.5	77 65	127.4	38 50.4	77 64	127.8	38 27.3	77 64	128.2	38 04.1	77 64	128.6	37 40.9	78 63	129.0	37 17.5	78 63	129.4	36 54.1	78 63	129.8	8	
	9	38 57.4	70 66	126.0	38 34.6	76 66	126.4	38 11.8	76 65	126.8	37 48.9	76 65	127.2	37 26.0	77 64	127.6	37 02.9	77 64	128.0	36 39.8	77 64	128.4	36 16.5	78 63	128.8	9	
82	40	38 17.8	75 67	125.0	37 55.3	75 66	125.4	37 32.7	75 66	125.8	37 10.0	76 66	126.3	36 47.3	76 65	126.7	36 24.4	76 65	127.1	36 01.5	77 65	127.5	35 38.5	77 64	127.9	40	162
	1	37 37.9	74 67	124.1	37 15.5	75 67	124.5	36 53.1	75 67	124.9	36 30.7	75 68	125.3	36 08.1	75 66	125.7	35 45.4	76 66	126.1	35 22.7	70 65	126.5	34 59.9	76 65	126.9	1	
	2	36 57.4	74 68	123.1	36 35.3	74 68	123.6	36 13.1	74 67	124.0	35 50.8	74 67	124.4	35 28.5	75 67	124.8	35 06.0	75 80	125.2	34 43.5	75 66	125.6	34 20.9	76 60	126.0	2	
	3	36 16.6	73 69	122.2	35 54.7	73 68	122.6	35 32.6	73 68	123.1	35 10.6	74 68	123.5	34 48.4	74 68	123.9	34 26.1	74 67	124.3	34 03.8	75 67	124.7	33 41.4	75 67	125.1	3	
	4	35 35.3	72 69	121.3	35 13.6	73 69	121.8	34 51.8	73 69	122.2	34 29.9	73 68	122.6	34 07.9	73 68	123.0	33 45.8	74 68	123.4	33 23.7	74 68	123.8	33 01.4	74 67	124.2	4	
77	45	34 53.6	72 70	120.4	34 32.1	72 70	120.9	34 10.5	72 69	121.3	33 48.8	73 69	121.7	33 27.0	73 69	122.1	33 05.1	73 69	122.5	32 43.1	73 68	122.9	32 21.1	74 68	123.3	45	167
	6	34 11.6	71 71	119.6	33 50.3	71 70	120.0	33 28.8	72 70	120.4	33 07.3	72 70	120.8	32 45.7	72 69	121.3	32 24.0	72 69	121.7	32 02.2	73 69	122.1	31 40.3	73 69	122.5	6	
	7	33 29.2	70 71	118.7	33 08.0	71 71	119.2	32 46.8	71 71	119.6	32 25.4	71 70	120.0	32 04.0	72 70	120.4	31 42.5	72 70	120.8	31 20.9	72 70	121.2	30 59.2	72 69	121.6	7	
	8	32 46.5	70 72	117.9	32 25.5	70 72	118.3	32 04.4	70 71	118.7	31 43.2	71 71	119.2	31 21.9	71 71	119.6	31 00.6	71 70	120.0	30 39.2	72 70	120.4	30 17.7	72 70	120.8	8	
	9	32 03.4	69 72	117.1	31 42.6	70 72	117.5	31 21.6	70 72	117.9	31 00.6	70 72	118.3	30 39.5	79 71	118.7	30 18.4	71 71	119.2	29 57.1	71 71	119.6	29 35.8	71 70	120.0	9	
72	50	31 20.0	69 73	116.3	30 59.4	69 73	116.7	30 38.6	69 72	117.1	30 17.7	70 72	117.5	29 56.8	70 72	117.9	29 35.8	70 71	118.3	29 14.7	70 71	118.7	28 53.6	71 71	119.2	50	172
	1	30 36.4	68 73	115.5	30 15.8	69 73	115.9	29 55.2	69 73	116.3	29 34.5	69 73	116.7	29 13.8	69 72	117.1	28 52.9	70 72	117.5	28 32.0	70 72	117.9	28 11.0	70 71	118.4	1	
	2	29 52.4	68 74	114.7	29 32.0	68 74	115.1	29 11.6	68 73	115.5	28 51.0	69 73	115.9	28 30.4	69 73	116.3	28 09.7	69 72	116.8	27 49.0	69 72	117.2	27 28.1	70 72	117.6	2	
	3	29 08.1	67 74	113.9	28 47.9	68 74	114.3	28 27.6	68 74	114.7	28 07.2	68 73	115.1	27 46.8	68 73	115.6	27 26.2	69 73	116.0	27 05.6	69 73	116.4	26 45.0	69 72	116.8	3	
	4	28 23.6	67 75	113.1	28 03.5	67 74	113.5	27 43.4	67 74	114.0	27 23.1	68 74	[illegible]	27 02.8	68 71	114.8	26 42.5	68 73	115.2	26 22.0	68 73	115.6	26 01.5	69 73	116.0	4	
67	55	27 38.9	66 75	112.4	27 18.9	67 75	112.8	26 58.9	67 75	113.2	26 38.8	67 74	[illegible]	26 18.6	67 74	114.0	25 58.4	68 74	114.5	25 38.1	68 74	114.9	25 17.7	68 73	115.3	55	177
	6	26 53.9	66 75	111.6	26 34.0	66 75	112.0	26 14.2	66 75	112.5	25 54.2	67 75	[illegible]	25 34.2	67 75	113.3	25 14.1	67 74	113.7	24 53.9	67 74	114.1	24 33.7	68 74	114.5	6	
	7	26 08.6	65 76	110.9	25 48.9	66 76	111.3	25 29.2	66 75	111.7	25 09.4	68 75	[illegible]	24 49.5	66 75	112.6	24 29.5	67 75	113.0	24 09.5	67 74	113.4	23 49.4	67 74	113.8	7	
	8	25 23.2	65 76	110.2	25 03.6	65 76	110.6	24 44.0	66 76	111.0	24 24.3	66 76	111.4	24 04.5	[illegible]	111.8	23 44.7	66 75	112.2	23 24.8	66 75	112.7	23 04.9	67 75	113.1	8	
	9	24 37.5	65 76	109.5	24 18.1	65 76	109.9	23 58.6	65 76	110.3	23 39.0	65 76	110.7	23 19.4	66 76	111.1	22 59.7	66 75	111.5	22 39.9	66 75	111.9	22 20.1	66 75	112.3	9	
62	60	23 51.6	64 77	108.7	23 32.3	64 77	109.2	23 12.9	65 76	109.6	22 53.5	65 76	110.0	22 34.0	65 76	110.4	22 14.4	65 76	110.8	21 54.8	80 76	111.2	21 35.1	66 75	111.6	60	182
	1	23 05.6	64 77	108.0	22 46.4	64 77	108.5	22 27.1	64 77	108.9	22 07.8	65 77	109.3	21 48.4	65 76	109.7	21 28.9	65 76	110.1	21 09.4	65 76	110.5	20 49.8	65 76	110.9	1	
	2	22 19.3	64 77	107.4	22 00.2	64 77	107.8	21 41.1	64 77	108.2	21 21.8	64 77	108.6	21 02.6	64 77	109.0	20 43.2	65 76	109.4	20 23.8	65 76	109.8	20 04.4	65 76	110.2	2	
	3	21 32.9	63 78	106.7	21 13.9	63 77	107.1	20 54.9	64 77	107.5	20 35.8	61 77	107.9	20 16.6	64 77	108.3	19 57.4	64 77	108.7	19 38.1	64 77	109.1	19 18.7	65 76	109.5	3	
	4	20 46.3	63 78	106.0	20 27.4	63 78	106.4	20 08.5	63 78	106.8	19 49.5	63 77	107.2	19 30.4	64 77	107.6	19 11.3	64 77	108.1	18 52.1	64 77	108.5	18 32.9	64 77	108.9	4	
57	65	19 59.6	63 78	105.3	19 40.8	63 78	105.7	19 21.9	63 78	106.2	19 03.0	63 78	106.6	18 44.1	63 78	107.0	18 25.1	63 77	107.4	18 06.0	64 77	107.8	17 46.9	64 77	108.2	65	187
	6	19 12.7	62 78	104.7	18 54.0	62 78	105.1	18 35.2	63 78	105.5	18 16.4	63 78	105.9	17 57.6	63 78	106.3	17 38.7	63 78	106.7	17 19.7	63 77	107.1	17 00.7	63 77	107.5	6	
	7	18 25.7	62 79	104.0	18 07.1	62 78	104.4	17 48.4	62 78	104.8	17 29.7	62 78	105.2	17 10.9	63 78	105.7	16 52.1	63 78	106.1	16 33.2	63 78	106.5	16 14.3	63 78	106.9	7	
	8	17 38.5	62 79	103.4	17 20.0	62 79	103.8	17 01.4	62 79	104.2	16 42.8	62 78	104.6	16 24.1	62 78	105.0	16 05.4	62 78	105.4	15 46.6	63 78	105.8	15 27.8	63 78	106.2	8	
	9	16 51.2	61 79	102.7	16 32.8	62 79	103.1	16 14.3	62 79	103.5	15 55.7	62 79	103.9	15 37.1	62 78	104.4	15 18.5	62 78	104.8	14 59.8	62 78	105.2	14 41.1	62 78	105.6	9	
52	70	16 03.8	61 79	102.1	15 45.4	61 79	102.5	15 27.0	61 79	102.9	15 08.5	62 79	103.3	14 50.0	62 79	103.7	14 31.5	62 79	104.1	14 12.9	62 78	104.5	13 54.3	62 78	104.9	70	192
	1	15 16.3	61 79	101.4	14 58.0	61 79	101.9	14 39.6	61 79	102.3	14 21.2	61 79	102.7	14 02.8	62 79	103.1	13 44.3	62 79	103.5	13 25.8	62 79	103.9	13 07.3	62 78	104.3	1	
	2	14 28.7	61 80	100.8	14 10.4	61 79	101.2	13 52.1	61 79	101.6	13 33.8	61 79	102.0	13 15.5	61 79	102.4	12 57.1	61 79	102.9	12 38.6	61 79	103.3	12 20.2	62 79	103.7	2	
	3	13 40.9	60 80	100.2	13 22.8	61 80	100.6	13 04.5	61 60	101.0	12 46.3	61 79	101.4	12 28.0	61 79	101.8	12 09.7	61 79	102.2	11 51.3	61 79	102.6	11 33.0	61 79	103.0	3	
	4	12 53.1	60 80	99.6	12 35.0	60 80	100.0	12 16.8	61 80	100.4	11 58.7	61 60	100.8	11 40.5	61 79	101.2	11 22.2	61 79	101.6	11 03.9	61 79	102.0	10 45.6	61 79	102.4	4	
47	75	12 05.2	60 80	99.0	11 47.1	60 80	99.4	11 29.1	60 80	99.8	11 10.9	80 60	100.2	10 52.8	61 80	100.6	10 34.6	61 80	101.0	10 16.4	61 79	101.4	9 58.1	61 79	101.8	75	197
	6	11 17.2	60 80	98.3	10 59.2	60 80	98.7	10 41.2	60 80	99.2	10 23.1	60 80	99.6	10 05.0	60 60	100.0	9 46.9	60 80	100.4	9 28.7	61 80	100.8	9 10.6	61 79	101.2	6	
	7	10 29.1	60 80	97.7	10 11.2	60 80	98.1	9 53.2	60 60	98.5	9 35.2	60 60	98.9	9 17.2	80 80	99.4	8 59.1	60 80	99.8	8 41.0	60 60	100.2	8 22.9	60 80	100.6	7	
	8	9 41.0	60 80	97.1	9 23.1	60 80	97.5	9 05.2	60 60	97.9	8 47.2	60 80	98.3	8 29.2	60 80	98.7	8 11.2	60 80	99.1	7 53.2	60 80	99.6	7 35.1	60 60	100.0	8	
	9	8 52.8	59 80	96.5	8 34.9	60 80	96.9	8 17.1	80 80	97.3	7 59.2	60 80	97.7	7 41.2	60 80	98.1	7 23.3	60 60	98.5	7 05.3	60 60	98.9	6 47.3	60 80	99.4	9	
42	80	8 04.6	59 80	95.9	7 46.7	59 80	96.3	7 28.9	60 80	96.7	7 11.0	60 80	97.1	6 53.1	60 80	97.5	6 35.2	60 60	97.9	6 17.3	80 80	98.3	5 59.3	60 80	98.7	80	202
	1	7 16.2	59 81	95.3	6 58.5	59 81	95.7	6 40.6	59 80	96.1	6 22.8	59 80	96.5	6 05.0	60 60	96.9	5 47.1	60 80	97.3	5 29.2	60 80	97.7	5 11.3	60 80	98.1	1	
	2	6 27.9	59 81	94.7	6 10.1	59 81	95.1	5 52.4	59 81	95.5	5 34.6	59 80	95.9	5 16.8	59 60	96.3										2	
	3	5 39.5	59 81	94.1	5 21.8	59 81	94.5	5 04.0	59 81	94.9																3	